Social Tensions with Head-Mounted Displays for Accessibility

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ABSTRACT

Head-mounted displays (HMDs) can enhance accessibility for people with disabilities, but stigmatization and social misperception may hinder use of these devices in social contexts. In this paper, to motivate and encourage future work, we outline key social challenges in using HMDs for accessibility.

CCS CONCEPTS

• **Human-centered computing** → *Accessibility theory, concepts and paradigms*; • **Social and professional topics** → *People with disabilities.*

KEYWORDS

accessibility, head-mounted displays, assistive technology, social perceptions

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Figure 1: Examples of HMDs to support accessibility: (top) real-time captions for people who are deaf and hard of hearing [6] and (bottom) visually enhancing information (*e.g.*, magnifying, increasing contrast) for people with low vision [20].

INTRODUCTION

Head-mounted displays (HMDs) hold tremendous potential to enhance accessibility for people with disabilities, such as providing real-time captioning for people who are deaf or hard of hearing [6–8, 17], augmenting vision for people with low vision [4, 20, 23], allowing hands-free computer access for people with motor impairments [13, 15], and providing vocabulary support for people with language impairments [22]; Figure 1 shows examples. At the same time, the use of HMDs for these and other assistive purposes may give rise to unique issues of social acceptability.

Drawing on our experiences designing and evaluating HMD-based approaches to address real-world accessibility problems [6–8, 13, 18, 20, 22] as well as other work, this workshop paper outlines key social acceptability challenges that will need to be addressed for HMDs to achieve widespread success as an assistive technology. Specifically, we detail: (1) tensions between the evolving societal perceptions of HMDs and concerns of stigma and misperception that can arise with assistive technologies, (2) the need to provide assistive support without undue attentional cost and while maintaining expectations for person-to-person communication, and (3) issues of balancing the sensing needs of many of these HMD-based AT systems with the privacy needs of non-wearers. Through this synthesis, we identify open questions and provide guidance for future researchers in this space.

STIGMA AND SOCIAL ACCEPTABILITY

While public perceptions of wearable devices, particularly wrist-worn and health-related sensors, have improved in the past decade, the attitude toward HMDs specifically is far more tepid—even resistant [10, 11]. Koelle *et al.* [12], for example, found that HMDs are distinct from other wearables because they are perceived to be constantly recording information. Employing HMDs for assistive purposes such as those described in the Introduction may yield further complexities due to the stigmatizing effect of ATs [16]. Misperceptions, for example, that AT users are less capable than non-AT users, can lead to social stress and abandonment of AT devices [9, 19]. How the social perceptions of HMDs and ATs may counter or magnify one another is an open question.

As a first step, Profita *et al.* [18] conducted a large-scale survey on perceptions of HMD use to examine how information provided about a wearer's disability and the device's purpose affected perceptions by third-party observers. HMD use (in this case a Google Glass device) was seen as more socially acceptable when there were visual indicators that the wearer had a disability (*i.e.*, dark glasses and a white cane) than when there were no visual indicators; see Figure 2. Moreover, when observers were told that the HMD use was *assistive* (used to help with transit navigation), there was higher acceptance than for non-assistive use (checking email).

For mainstream HMDs that are being repurposed for assistive uses (as opposed to HMDs specifically designed as AT, *e.g.*, [4]), Profita *et al.* [18]'s findings suggest that communicating the assistive nature

Figure 2: In Profita *et al.'s* study [18], HMD use was seen as more socially acceptable when there were (top right and bottom) visual indicators that the wearer had a disability (*i.e.*, wore dark glasses and held a white cane) than when (top left) no visual indicators were present.

of the device directly or indirectly to onlookers may counter some of the negative attitudes towards HMDs. This conclusion raises an important tension in that, as discussed above, individuals with disabilities can be sensitive to devices that draw unwanted attention to their disability [19]. How can HMDs for assistive purposes be employed in a way that will allow the wearer to disclose that purpose, but only when desired?

EFFECTIVE COMMUNICATION SUPPORT

HMDs are particularly promising for communication support. For example (Figure 3), Jain *et al.* [6–8] explored HMD-based access to spoken conversation for people who are deaf or hard of hearing, through both real-time captioning on an HMD as well as a system that provided visual indicators of sound location to support speechreading (lipreading) in group conversations. Similarly but for a different domain, Washington *et al.* [21] developed a Google Glass application that provides social cues to children with autism through automatic facial expression recognition. Williams *et al.* [22] designed and evaluated an HMD-based approach to provide private visual and auditory vocabulary prompts for people with aphasia, an acquired language disorder.

These projects have yielded many positive findings, for example, that HMD-based vocabulary prompts for people with aphasia can support independent speech and eye contact with a conversation partner [22]. However, important challenges have also emerged. Providing additional information during a task that is already arduous for some individuals (*i.e.*, spoken conversation) can result in high cognitive effort [22] and attention loss [14]. Some HMD devices (*e.g.*, Microsoft HoloLens) obscure the wearer's eyes and facial expressions, which can interfere with face-to-face communication [6]. HMDs also have the potential to reinforce disparities in who takes on the burden of adapting to their conversation partner's needs. For instance, rather than encouraging hearing people to learn sign language, HCI research tends to focus on helping deaf people communicate via speech, thus placing the burden of adaptation on the deaf person (including some of our own projects, *e.g.*, [6, 8]). Because HMDs provide *private* visual and auditory support, they may reinforce this burden disparity more than a shareable form factor like a smartphone or tablet, where the conversation partner can also consume assistive information if desired. Addressing these design challenges will likely require advances in hardware (*e.g.*, to ensure that the wearer's eyes are visible) and user interaction (*e.g.*, to reduce cognitive load), as well as further study of social issues such as burden.

SENSING, DATA COLLECTION, AND DEVICE CAPABILITIES

HMD systems for accessibility often need to continuously capture, process, and potentially archive data streams from microphones, cameras, and/or other sensors (*e.g.*, to provide real-time captions [7], enhanced visual information [23], or conversational cues [22]). But while extensive information about nearby people and phenomena can enable a wide range of AT solutions, unrestrained data collection raises issues of surveillance, (in)voluntary information sharing, and opportunities for misuse.

Recognizing some of these concerns, Ahmed *et al.* [2] investigated the use of HMDs in a workplace environment and found that sighted individuals were more comfortable sharing personal data such as demographics, contact information, and social media accounts with visually impaired colleagues using HMDs as assistive devices than with other sighted colleagues. Additionally, participants were even more comfortable providing this information when they were assured that they could control how their information would be shared. While researchers have begun to investigate solutions for preserving the privacy of observers / bystanders for general HMD use (*e.g.*, using built-in facial obfuscation algorithms for observers [3]), Ahmed *et al.*'s [2] study highlights that privacy concerns and potentially successful solutions may play out differently in an accessibility context.

Individuals with disabilities have also been surveyed about their preferred device capabilities [1, 5, 19]. To provide useful assistive feedback, devices must be capturing information about the world around them. But where and when does this functionality turn off, if ever? Some people with disabilities would greatly benefit from the ability to store and recall information. How can this be done with respect for observer privacy, and how far back should the device recall? Finally, the capabilities of these devices may be abused in more sensitive contexts (bathrooms, meetings, confidential documents, accidental eavesdropping, *etc.*). But if a non-disabled person has access to this information, why shouldn't a disabled person?

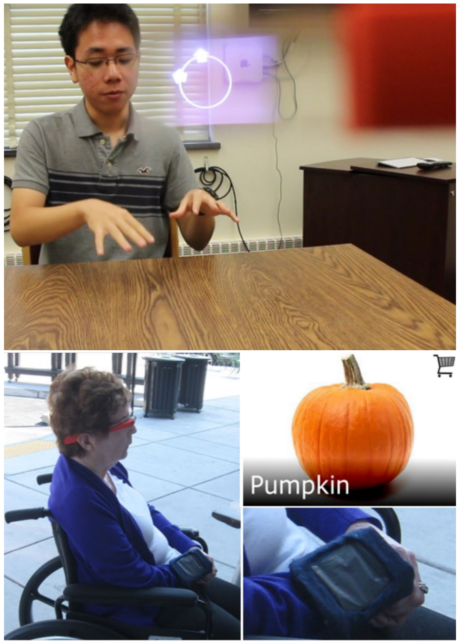

Figure 3: HMDs may be particularly useful for communication support: (top) Jain *et al*. [7] used HMDs to support speechreading in group conversations for deaf and hard of hearing people, (bottom) Williams *et al*. [22] used HMDs to provide visual and auditory vocabulary prompts for people with aphasia.

A CLOSING NOTE

HMDs for accessibility is a promising research area, and we hope this synthesis of social challenges will guide researchers in building more effective HMD-based AT systems.

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